

A Status Survey of Freshwater Mussel Populations in the Upper Clinch River, Tazewell County, Virginia

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INTRODUCTION

Previous freshwater mussel surveys (1912-1997) at sites in the upper Clinch River in Tazewell County, Virginia, documented at least 27 species (Table 1). Presently, the mussel fauna in the upper Clinch River has been reduced to about 18 species, due principally to human impacts in the watershed and river. Degradation continues to jeopardize the mussel fauna and significantly impedes species recovery. For example, an estimated 5,300 liters (1,400 gallons) of a rubber accelerator (Octocure 554) spilled into the river from an overturned tanker truck on U.S. Route 460 in August 1998, just above Cedar Bluff near Clinch River Mile (CRM) 323.0. The toxic spill killed over 7,000 mussels of 16 species, including 182 endangered tan riffleshells, *Epioblasma florentina walkeri*, 51 endangered purple beans, *Villosa purpurpurea*, and 20 endangered rough rabbitsfoot *Quadrula cylindrica strigillata* (L.M. Koch, USFWS, pers. comm.). The majority of mussels were killed in a 5-6 mile (8-9 km) reach of river from Cedar Bluff downstream to Richlands. Previous mussel collections were made in this reach of river near Cedar Bluff and downstream (Table 1), with little survey effort focused on the upstream reach of river. This study was initiated in the summer of 1999 to determine the present status of mussel populations in the headwaters of the Clinch River above the town of Cedar Bluff upstream to Tazewell, Tazewell County.

MATERIALS AND METHODS

Study Area

During the summer of 1999, approximately 43 km (27 miles) of the upper Clinch River, [CRM 324.0-350.5 (CRK 521.4-564.1)], in Tazewell County, Virginia were surveyed for freshwater mussels (Fig. 1). This section of river drains two physiographic provinces, the Cumberland Plateau to the northwest and the Valley and Ridge to the southeast. The stream bottom is underlain primarily with limestone and shale, and historically was well suited for freshwater mussels. The river is fourth order in size throughout Tazewell County and features moderate to high gradient riffle-run fluvial morphology. The majority of our survey sites were located in the mainstem of the Clinch River, from above Cedar Bluff upstream to Tazewell. We also surveyed sites in second-order tributary streams. Topographic maps with locations of collection sites are on file at the Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg, Virginia.

Qualitative Sampling

Freshwater mussels were sampled at 49 sites (Fig. 1, Tables 2 and 3), which were selected using 7.5 minute U.S. Geological Survey (USGS) topographic maps. Sampling sites were chosen based on accessibility

¹The Unit is supported jointly by the U.S. Geological Survey, the Virginia Department of Game and Inland Fisheries, Virginia Polytechnic Institute and State University, and the Wildlife Management Institute.

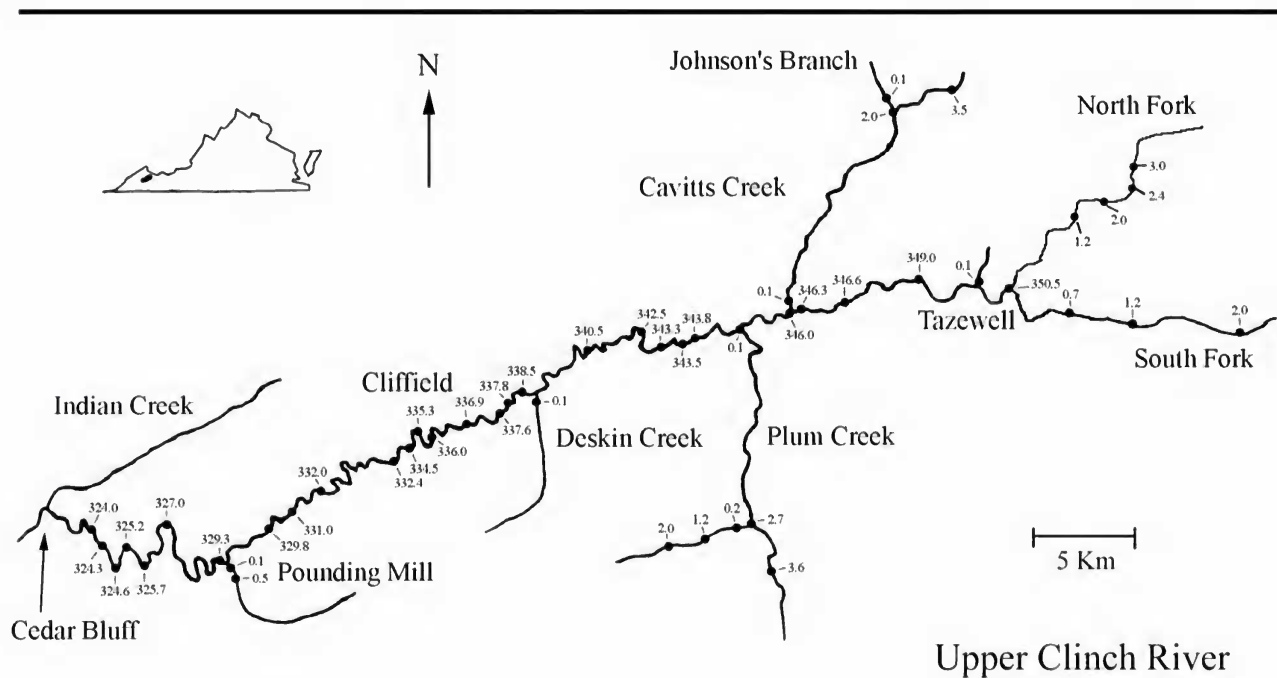


Fig. 1. Sites surveyed in 1999 for freshwater mussels in the upper Clinch River, Tazewell County, Virginia. Sites are reported as river or creek miles.

from roads or bridges, remoteness, and habitat types (e.g., mainstem sites vs tributary sites). The majority of our sampling effort was focused in riffles and runs that contained suitable substrates for freshwater mussels. Sites were surveyed by snorkeling, with 2-4 individuals searching side-by-side and moving upstream. A few sites in tributaries were too shallow for snorkeling; at these sites we walked in an upstream direction looking for live mussels protruding from the stream bottom. All fresh dead or relic shell material was also collected. Mussels were identified to species, counted, and immediately returned into the substrate at their collection site. Scientific names of mussels follow those of Turgeon et al. (1998), and the conservation status of each species follows that of Williams et al. (1992).

Estimates of substrate composition were assessed visually, based on the judgement of individual surveyors. At each site, the distance snorkeled was measured with a range finder (Bushnell, yardage pro 400) or visually estimated. Latitude and longitude were obtained with a March-II-E GPS unit (Corvallis Micro-Technology, Inc.). In addition to data reported in this paper, mussel abundance, qualitative observations on stream habitat, comments on the surrounding land use,

and the latitude and longitude of all sites are reported in Jones et al. (1999).

RESULTS

Approximately 254 survey hours were spent sampling the upper Clinch River between Cedar Bluff and Tazewell. At each site, a mean of 5.2 person-hours was spent snorkeling, covering a mean distance of nearly 360 m. We recorded eight species of live freshwater mussels, totaling 4,115 individuals at the 28 sites sampled in the river (Table 2) and 21 sites sampled in tributaries (Table 3). These species, in order of relative abundance, were as follows (Table 4): rainbow mussel, *Villosa iris*, (71.76%), Cumberland moccasinshell, *Medionidus conradicus*, (12.68%), Tennessee heelsplitter, *Lasmigona holstonia*, (4.81%), Tennessee clubshell, *Pleurobema oviforme*, (4.73%), Tennessee pigtoe, *Fusconaia barnesiana*, (3.59%), wavyrayed lampmussel, *Lampsilis fasciola*, (2.35%), littlewing pearl mussel, *Pegias fabula*, (0.02%), and kidneyshell, *Ptychobranhus fasciolaris*, (0.02%). Seven additional species were represented only by the collection of relic shells; these species were the mucket

Table 1. Mussel species collected in the upper Clinch River, Tazewell County, Virginia. Collection records by Ortmann (1918), Stansbery et al. (1986), Ahlstedt (1991), Ahlstedt & Tuberville (1997), Winston & Neves (1997), Watson (1999), include sites at Cedar Bluff near CRM 322.5, but with few to no sites upstream. The present study (1999) is from CRM 324.0 just above Cedar Bluff, upstream to Tazewell at CRM 350.5.

Species	Publication Date						
	1918 ¹	1986 ²	1991 ³	1997 ⁴	1997 ⁵	1999 ⁶	1999 (Present)
<i>Actinonaias ligamentina</i>							relic shells
<i>Actinonaias pectorosa</i>		X			X	X	relic shells
<i>Alasmidonta marginata</i>	X						
<i>Alasmidonta viridis</i>	X	X					relic shells
<i>Elliptio dilatata</i>	X						
<i>Epioblasma capsaeformis</i> *	X						
<i>Epioblasma f. walkeri</i> *		X		X	X	X	
<i>Epioblasma haysiana</i>	X						
<i>Fusconaia barnesiana</i>	X	X		X	X	X	X
<i>Fusconaia cor</i> *					X		
<i>Fusconaia cuneolus</i> *			X				
<i>Fusconaia subrotunda</i>	X	X				X	relic shells
<i>Lampsilis fasciola</i>	X	X		X	X	X	X
<i>Lampsilis ovata</i>	X			X	X	X	
<i>Lasmigona costata</i>	X	X			X	X	relic shells
<i>Lasmigona holstonia</i>	X	X			X		X
<i>Lexingtonia dolabelloides</i>	X	X			X		
<i>Medionidus conradicus</i>	X	X		X	X	X	X
<i>Pegias fabula</i> *		X					X
<i>Pleurobema oviforme</i>	X	X			X	X	X
<i>Ptychobranhus fasciolaris</i>		X			X	X	X
<i>Ptychobranhus subtentum</i>	X	X			X	X	relic shells
<i>Quadrula c. strigillata</i> *	X	X			X	X	
<i>Strophitus undulatus</i>	X						
<i>Villosa iris</i>	X	X	X	X	X	X	X
<i>Villosa perpurpurea</i> *	X	X		X	X	X	
<i>Villosa v. vanuxemensis</i>					X	X	relic shells
Total number of species (27)	19	17	2	7	17	15	8

Actinonaias ligamentina, pheasantshell, *Actinonaias pectorosa*, slippershell mussel, *Alasmidonta viridis*, longsolid, *Fusconaia subrotunda*, flutedshell, *Lasmigona costata*, fluted kidneyshell, *Ptychobranchus subtentum*, and mountain creekshell, *Villosa v. vanuxemensis*.

The only federally endangered mussel found during the survey was one male littlewing pearlymussel, *Pegias fabula*, (length 40 mm, height 29 mm). This mussel was found at CRM 332.0, in a section of river between Clifffield and Pounding Mill. The riffle where the mussel was found was clean cobble, pebble, and sand free of silt; however, this reach of the river generally appeared moderately to heavily silted. At the Route 637 bridge crossing near Pounding Mill (CRM 329.8), a relic shell of this species also was found about 50 m downstream of the bridge. The habitat above and below the bridge is considered excellent for mussels, and other individuals of this species may inhabit this reach of river.

The state endangered *Lasmigona holstonia* was collected at 10 sites in five small tributary streams, and two sites in the mainstem Clinch River. However, each of the mainstem sites was immediately downstream of a tributary. The tributaries where this species occurs include the following streams: North Fork Clinch River, South Fork Clinch River, Cavitts Creek, Plum Creek, and West Fork Plum Creek (Table 3). Both the North Fork and South Fork contain healthy reproducing populations of *L. holstonia*. The greatest concentration was found in the South Fork Clinch River at River Mile 0.7 (Table 3), but this stream reach also was heavily sedimented with 30-50 mm of fine silt. Cattle have direct access to the stream, and the banks are severely degraded. This mussel species is restricted to small tributary streams, and it seems to be relatively tolerant of silt.

DISCUSSION

We recorded live specimens of eight mussel species in the present study, with only six of these species present in readily detectable numbers. Relic shells representing seven additional mussel species also were collected in this survey. In addition, the shell of a female tan riffleshell, *Epioblasma florentina walkeri*, a federally endangered species, was collected near Clifffield in 1985 (R.J. Neves, unpub. data). Therefore, if we assume that the 43 km section of the river between Cedar Bluff and Tazewell contained at least 16 species from historic records, then at least half of the fauna has been functionally extirpated. However, historic collection records (Table 1) indicate that at least 27 mussel species inhabited the Clinch River in Tazewell County, indicating an even greater faunal loss. The causes of this faunal decline are unknown, but anthropogenic impacts to the river were evident during our surveys. Moreover, based on the almost complete absence of relic shells of the original mussel fauna, many species likely were extirpated more than 20 years ago. The extant mussel species are considered tolerant of current watershed conditions and presumably withstood past perturbations to the river.

Although documentation of the causes for extirpation is lacking, inadequate or faulty treatment of sewage from Tazewell may be a contributing factor. Goudreau (1988) reported finding no live mussels in the Clinch River for 3.75 km (2.3 miles) below the sewage treatment plant located in South Tazewell. We also surveyed several sites in this reach of the river and found few live mussels. However, sewage effluent from the small treatment facility at Tazewell does not explain the low mussel diversity throughout the surveyed reaches of the upper Clinch River. Other impacts such as sedimentation, wastewater discharges from

Table 1. Continued.

*Federally endangered

X=live specimens in 1991-1999 surveys, and shells in 1918-1986 surveys.

¹Sites were surveyed at Cedar Bluff (exact locations are unknown) in 1912 and 1913.

²Site at Cedar Bluff (CRM 322.7) was surveyed in 1981.

³Site at Cedar Bluff (CRM 322.7) was surveyed in 1979.

⁴Sites were surveyed at Cedar Bluff (CRM 322.7-322.8) in 1988 and 1994.

⁵Sites at Cedar Bluff (CRM 322.7) and Indian Creek were surveyed in 1995 and 1996.

⁶Indian Creek was surveyed in the summers of 1996 and 1997.

Table 2. Number of live mussel species found at 28 sampling sites in the upper Clinch River, Tazewell County, Virginia.

Species	River Miles													
	324.0	324.3	324.6	325.2	325.7	327.0	329.0	329.8	331.0	332.0	332.4	334.5	335.3	336.0
<i>Villosa iris</i>	180	150	210	100	400	220	15	173	32	34	115	50	35	35
<i>Medionidus conradicus</i>	80	15	32	20	50	45	---	36	15	22	89	15	15	18
<i>Lasmigona holstonia</i>	---	---	---	---	---	---	---	---	---	---	---	---	---	---
<i>Pleurobema oviforme</i>	1	3	4	2	8	---	---	15	1	---	---	1	15	32
<i>Fusconaia barnesiana</i>	1	5	1	3	1	2	---	---	3	---	7	4	5	17
<i>Lampsilis fasciola</i>	10	---	5	3	10	1	---	13	3	5	26	3	2	2
<i>Pegias fabula</i>	---	---	---	---	---	---	---	---	---	1	---	---	---	---
<i>Ptychobranthus fasciolaris</i>	1	---	---	---	---	---	---	---	---	---	---	---	---	---
Total/site	273	173	254	128	469	268	15	237	54	62	237	73	72	104
Mussels/hour of effort	20.2	38.4	25.4	10.7	46.9	16.7	2.3	19.7	10.8	12.4	31.6	8.1	14.4	8.6

Table 2. Continued.

Species	River Miles																
	336.9	337.6	337.8	338.5	340.5	342.5	343.3	343.5	343.8	346.0	346.3	346.6	349.0	350.5			
<i>Villosa iris</i>	69	74	32	25	40	2	---	---	---	45	39	17	5	147			
<i>Medionidus conradicus</i>	9	24	10	10	2	---	---	---	---	1	---	---	---	---			
<i>Lasnigona holstonia</i>	---	---	---	---	---	---	---	---	---	1	---	---	---	5			
<i>Pleurobema oviforme</i>	21	16	16	10	4	19	---	---	---	3	---	---	---	---			
<i>Fusconaia barnesiana</i>	---	---	1	2	39	2	---	3	1	13	10	6	---	---			
<i>Lampsilis fasciola</i>	---	7	5	2	---	10	---	---	---	---	---	---	---	---			
<i>Pegias fabula</i>	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
<i>Ptychobranchus fasciolaris</i>	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Total/site	99	121	64	49	85	23	0	3	1	63	49	23	5	152			
Mussels/hour of effort	16.5	20.2	10.7	12.3	8.1	7.6	0	1.0	0.1	8.4	14.0	7.0	2.5	38.0			

Table 3. Number and species of live mussels at 21 sampling sites in tributary streams of the upper Clinch River, Tazewell County, Virginia, from June through August 1999.

Species	Pounding Mill Branch		Desklin Creek	Creek Miles					West Fork Plum Creek			Johnson Branch
	0.1	0.5		0.1	2.7	3.6	0.2	1.2	2.0	0.1		
<i>Villosa iris</i>	---	---	1	30	---	---	---	---	1	---	---	
<i>Medionidus conradicus</i>	---	---	---	---	---	---	---	---	---	---	---	
<i>Lasmigona holstonia</i>	---	---	---	---	1	---	15	19	---	---	---	
<i>Pleurobema oviforme</i>	---	---	---	40	---	---	---	---	---	---	---	
<i>Fusconaia barnesiana</i>	---	---	---	15	---	---	---	---	---	---	---	
<i>Lampsilis fasciola</i>	---	---	---	---	---	---	---	---	---	---	---	
<i>Pegias fabula</i>	---	---	---	---	---	---	---	---	---	---	---	
<i>Ptychobranthus fasciolaris</i>	---	---	---	---	---	---	---	---	---	---	---	
Total/site	0	0	1	85	1	0	15	20	0	0	0	
Mussels/hour of effort	0	0	1.0	11.3	0.7	0	15.0	20.0	0	0	0	

Table 3. Continued.

Species	Cavitts Creek						Linconshire Branch		Creek Miles								
									North Fork Clinch						South Fork Clinch		
	0.1	2.0	3.5	0.1	1.2	2.0	2.4	3.0	0.7	1.2	2.0						
<i>Villosa iris</i>	10	18	50	1	122	236	1	---	170	---	---	---					
<i>Medionidus conradicus</i>	---	6	1	---	---	---	---	---	---	---	---	---					
<i>Lasmigona holstonia</i>	---	1	10	---	38	22	2	---	70	3	---	---					
<i>Pleurobema oviforme</i>	---	---	---	---	---	---	---	---	---	---	---	---					
<i>Fusconaia barnesiana</i>	---	2	1	---	---	1	---	---	1	---	---	---					
<i>Lampsilis fasciola</i>	---	---	---	---	---	---	---	---	---	---	---	---					
<i>Pegias fabula</i>	---	---	---	---	---	---	---	---	---	---	---	---					
<i>Ptychobranchus fasciolaris</i>	---	---	---	---	---	---	---	---	---	---	---	---					
Total/site	10	27	62	1	160	259	3	0	241	3	0	0					
Mussels/hour of effort	3.3	13.5	16.5	1.0	15.2	43.2	1.0	0	48.2	1.0	0	0					

Table 4. Summary of 1999 mussel collections in the upper Clinch River, Tazewell County, Virginia.

Species	Number collected	Percentage of collection	Sites of occurrence
<i>Villosa iris</i>	2,953	71.76	37
<i>Medionidus conradicus</i>	522	12.68	23
<i>Lasmigona holstonia</i>	198	4.81	14
<i>Pleurobema oviforme</i>	195	4.73	17
<i>Fusconaia barnesiana</i>	148	3.59	26
<i>Lampsilis fasciola</i>	97	2.35	15
<i>Pegias fabula</i>	1	0.02	1
<i>Ptychobranchus fasciolaris</i>	1	0.02	1
Total	4,115	100	49

residences along the river, and contaminant spills may have contributed to the decline. This section of the river has a very limited number of healthy mussel aggregations to allow mussels to recolonize impacted reaches of the river.

The small, mostly second-order tributary streams of the upper Clinch River have naturally low mussel diversity and would offer only 3-4 species to recolonize the mainstem Clinch. The only nearby tributary stream with a mussel assemblage similar to the Clinch is Indian Creek at Cedar Bluff. Watson (1999) reported 15 extant mussel species in this tributary (Table 1); however, mussel recolonization of the Clinch River above Cedar Bluff is impeded by an old mill dam located approximately 75 m upstream from the mouth of Indian Creek. A comparison between the mussel assemblages downstream and upstream of the mill dam demonstrates the effect this barrier has on recolonization. In a recent survey for rare mussels above and below the Business Route 460 bridge, which is just upstream of the mill dam, Beaty & Neves (1998) reported four species of live mussels from this reach of the river. Below the mill dam, 16 species were recorded in 1999, from the mouth of Indian Creek downstream to Richlands (L. M. Koch, USFWS, pers. comm.).

Mussel abundance and diversity is now low in the Clinch River headwaters, from its source at Tazewell downstream to about Clifffield. This approximately 24 km (15 mile) stretch of river is moderately to heavily silted, and appears to have been affected by wastewater effluent and habitat degradation from Tazewell. Excessive sediment inputs from tributaries degraded by livestock, such as the South Fork Clinch River and Plum Creek, also may be contributing to mussel

declines. Evidence of recent mussel recovery in this reach is lacking, and recruitment is probably occurring only at very low levels. Furthermore, there are few stream reaches in the upper river suitable for the reintroduction of laboratory-propagated juvenile mussels. One suitable location is the North Fork Clinch River above Tazewell (River Mile 1.2). This reach contained healthy populations of *Lasmigona holstonia* and *Villosa iris*, with young individuals of both species present. If necessary, population augmentation of *L. holstonia* may be feasible at this location. Mussel abundance and diversity begins to increase somewhere between Clifffield and Pounding Mill. This approximately 11 km (7 mile) section of river is moderately silted, but contains good habitat for mussels. There is evidence of limited mussel reproduction, with a few young individuals less than 20 mm collected in this reach during the survey. However, we consider this section of the river only marginally suitable for reintroduction of propagated juvenile mussels. The surrounding land use consists of pasture and small homes along the river banks; therefore, many riparian areas are not well protected. Mussel abundance improves significantly from Pounding Mill to above Cedar Bluff, with species diversity being about the same as the aforementioned section of river. This approximately 8 km (5 mile) section of the river appears clean, relatively free of silt, and is well protected by surrounding forest. Mussels are common, with young individuals present at all sites surveyed. From CRM 324.0 to 327.0, the river conditions appear excellent for the reintroduction of propagated juvenile mussels. This reach of river contains suitable flow and several gravel shoals more than 100 m in length that

appear adequate for reintroduction of species such as the endangered *Epioblasma florentina walkeri* and *Villosa perpurpurea*.

The occurrence of viable populations of federally endangered mussel species in the surveyed section of the upper Clinch River is unlikely. With the collection of only one live *Pegias fabula*, even the continued existence of this endangered species in the river is tenuous. A status survey covering the known range of this Cumberlandian species by Ahlstedt & Saylor (1995-1996) found only one small population in Virginia, in the upper North Fork Holston River. These authors noted that the species is extremely rare in the Virginia portion of its range. In the upper Clinch River, collection records indicate that *P. fabula* has been recorded only a few times: Cedar Bluff (1978; n=2) and Clifffield (1968; n=1) (Stansbery et al., 1986), and Clifffield (1985; n=1) (R. J. Neves, unpub. data). The state endangered *L. holstonia* is the only rare species collected during the survey in viable numbers; it is moderately abundant and reproducing in several of the small tributary streams of the upper Clinch River. These populations appear stable at this time.

The spill of toxic rubber accelerator at Cedar Bluff in August of 1998, immediately downstream of our study area, effectively extended the depauperate mussel fauna of the upper river another 8-9 km (5-6 miles) downstream. The accident killed at least 7,036 mussels of 16 species (L.M. Koch, USFWS, pers. comm.), to include eradicating the only population of endangered *E. f. walkeri*, and nine other mussel species in the mainstem Clinch River in Tazewell County (Table 5). Assuming that river conditions are now suitable for faunal recovery, we estimate that it will take decades for these mussel species to naturally recolonize the affected river reach, or require reintroductions over many years to achieve population levels comparable to those prior to the spill.

Compared to the original fauna of 16-27 mussel species, the upper Clinch River between Cedar Bluff and Tazewell, Virginia, has been severely depleted of both species richness and abundance. The reach from Tazewell to Clifffield appears degraded, with little or no evidence that the mussel fauna is improving in this part of the river. In contrast, the mussels in the reach from Pounding Mill to 0.5 km above Cedar Bluff seem to be reproducing. Several common species such as *M. conradicus*, *V. iris*, *L. fasciola*, *F. barnesiana*, and *P. oviforme* are common and reproducing in this 9 km reach of the river. Noticeably absent from the surveyed section of the river are many other common species for the Clinch River, such as *Lampsilis ovata*, *Ptychobranhus fasciolaris*, *P. subtentum*, *Lasmigona costata*, and *Villosa v. vanuxemensis*. Populations of

Table 5. Mussels killed by the 27 August, 1998 chemical tanker spill in the Clinch River at Cedar Bluff, Virginia. Mussels salvaged in the kill zone were from CRM 322.5 downstream to approximately CRM 317.0 at Richlands.

Species	Number salvaged
<i>Villosa iris</i>	3,602
<i>Lampsilis fasciola</i>	1,083
<i>Ptychobranhus fasciolaris</i>	721
<i>Fusconaia barnesiana</i>	604
<i>Medionidus conradicus</i>	190
<i>Epioblasma florentina walkeri</i> *	182
<i>Pleurobema oviforme</i>	165
<i>Actinonaias pectorosa</i>	144
<i>Lasmigona costata</i>	106
<i>Lampsilis ovata</i>	73
<i>Ptychobranhus subtentum</i>	66
<i>Villosa perpurpurea</i> *	52
<i>Villosa v. vanuxemensis</i>	26
<i>Quadrula cylindrica strigillata</i> *	20
<i>Elliptio dilatata</i>	1
<i>Strophitus undulatus</i>	1
Total (16 species)	7,036

*Federally endangered

these species are readily available in the lower river and could either be translocated or propagated for release to sites in need of restoration. If reintroduction efforts such as these are successful, then the establishment of self-sustaining populations of endangered tan riffleshell, purple bean, and other species in the river above Cedar Bluff could restore much of the fauna lost in the 20th century.

ACKNOWLEDGMENTS

The survey was funded by the U.S. Fish and Wildlife Service, Abingdon, Virginia. We would like to thank Leroy Koch and Kathleen Gilbert for assisting with fieldwork, and the many landowners in Tazewell County who granted us permission to access the river through their properties.

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